

REMARKS:

Claims 1, 2, 5 and 7 are amended; marked up versions of the amended claims are attached hereto pursuant to 37 C.F.R. § 1.121(c)(ii). Claims 1-17 are pending in the application. Reexamination and reconsideration of the application, as amended, are respectfully requested.

Applicant believes the foregoing amendments comply with requirements of form and thus may be admitted under 37 C.F.R. § 1.116(a). Alternatively, if these amendments are deemed to touch the merits, admission is requested under 37 C.F.R. § 1.116(b). In this connection, these amendments were not earlier presented because they are in response to the matters pointed out for the first time in the Final Office Action.

Lastly, admission is requested under 37 C.F.R. § 1.116(a) as presenting rejected claims in better form for consideration on appeal.

Claim 1 stands rejected under 35 U.S.C. § 102 (b) as being anticipated by Miura (U.S. Patent No. 5,748,822). Applicant respectfully traverses the rejection of the claims.

The present invention relates to an optical module and a connecting structure for an optical module which are used mainly in optical communication equipment or the like. The optical modules and connection structures of the present invention enable secure and easy mounting on an electric circuit board and are highly reliable.

Claim 1 of the present invention, as amended, is as follows:

1. An optical module comprising:
a substrate having a planar main surface and a groove in the main surface of the substrate;
an electric connection terminal provided on the substrate;
an optical element provided on the planar main surface of the substrate, the optical element being connected with the electric connection terminal; and

one end of a slender light transmitter fixed in the groove and optically coupled with the optical element.
(Emphasis Added.)

According to one aspect of the present invention and referring to Figures 1A and 1B, the optical module M1 includes connection terminals formed of copper wires at one end 1a of a package 1. The optical elements are electrically connected with the connection terminals. The optical elements include a light emitting element 3, a light receiving element 4 and an optical fiber 5 serving a slender light transmitter having one end optically connected to the light emitting element 3. These elements are arranged on a substrate 6. In the present invention, at least one end of the optical fiber 5 is arranged in the package 1. In one aspect of the present invention, a v-shaped groove for mounting the optical fiber 5 is formed in a main surface of the substrate 6 with high precision by anisotropic etching. (See Specification, at p. 7, line 7- p. 8, line).

The Office contends that Miura discloses an optical module with all the limitations set forth in the claims, citing Figures 11A-11D (See Office Action, p. 3, lines 1-6). Miura describes the Optical module shown in the Figures 11A-11D at col. 11, lines 12-29 as follows:

FIGS. 11A through 11D show a photo-diode array module to which the fifth embodiment of the present invention is applied.

As shown in FIG. 11A, a plurality of V-grooves 54B and a recessed portion 54C are formed on a mounting board 57 (the silicon substrate) by etching. Sloping surfaces of the V-grooves 54B and a sloping surface 54D of the recessed portion 54C are formed by (111) plane of the silicon crystal structure which depend on the characteristics of the crystal structure of the silicon substrate. The top surface of the mounting board 57 is formed by (100) plane of the silicon crystal structure.

As shown in FIG. 11B, a plurality of electrodes 58 (Au) are formed on the mounting board 57. The electrodes 58 extend from the sloping surface 54D (the array mounting surface) of the recessed portion 54C. Further, a solder layer 59 is formed on the array mounting surface 54D.

As shown in FIG. 11C, a photo-diode array 60, including a plurality of photo-diodes of the type having the light receiving surface on the bottom side, is placed on the solder layer 59. The photo-diode array 60 is fixed to the solder layer 59 on the array mounting surface 54D by soldering.

As shown in FIG. 11D, an optical fiber array 30A including a plurality of optical fibers is placed on the V-grooves 54B. A retaining board 61 (the silicon substrate) is placed on the optical fibers of the optical fiber array 30A, and the optical fibers are retained by the retaining board 61.

Applicant respectfully submits that Miura et al. cannot anticipate present claim 1. As amended, claim 1 requires the combination of "a substrate having a planar main surface and a groove in the main surface of the substrate" and "an optical element provided on the planar main surface of the substrate" and "one end of a slender light transmitter fixed in the groove and optically coupled with the optical element." Thus, amended claim 1 requires that the optical element be on a planar main surface and the groove be in the planar main surface. Applicant respectfully submits that Miura et al. does not show such a construction. In Miura et al., as shown in FIG. 11A, a plurality of V-grooves 54B and a recessed portion 54C are formed on a mounting board 57 (the silicon substrate) by etching. The photodiode array is placed on the recessed portion. The grooves however, are not apparently formed in the recessed portion. Thus, in Miura et al., the planar main

surface does not contain both the optical element and the groove as is required by the present invention. Thus, present claim 1 is very different from the construction of Miura et al. Further, nothing in Miura suggests a construction in which an optical element is placed on a planar main surface and the groove is in the same planar main surface. As such, present claim 1 patentably distinguishes over Miura et al. Withdrawal of the rejection and allowance of claim 1 is respectfully requested.

Claims 1-17 stand rejected under 35 U.S.C. § 102 (b) as being unpatentable over Beckwith (U.S. Patent No. 5,615,292) in view of Miura et al. Claims 1, 2, 5 and 7 have been amended. Applicant respectfully traverses the rejection as to the amended claims.

With respect to claim 1, set forth above, Applicant respectfully asserts that the combination of references cited by the Office does not render present claim 1 unpatentable because the combination of references does not teach or suggest the optical module having "a substrate having a planar main surface and a groove in the main surface of the substrate" and "an optical element provided on the planar main surface of the substrate" and "one end of a slender light transmitter fixed in the groove and optically coupled with the optical element."

Miura has already been discussed, supra. Beckwith is directed to a terminator for permanent connection to either end of a fiber optic cable which then provides transmission of electrical TTL logic signals from one end to the other. (See Beckwith, Abstract). Referring to FIG. 3, Beckwith requires flexible tubing 5 to provide strain relief for fiber optic cable 4. (Beckwith at 2:58-60) In Beckwith, both tubing 5 and cable 4 being retained in openings 20 and 21 in body 2. (Beckwith at 2:59-60) In Figure 3, Body 2 is shown with cover 1 removed as required to permit assembly within body 2 of a known type of light sender 9 such as a Hewlett Packard HFBR1528, a known type of light receiver 10 such as a Hewlett Packard HFBR2528 and associated circuit 11 on printed circuit board 12. (Beckwith at 2:60-65).

Beckwith does not teach or suggest "a substrate having a planar main surface and a groove in the main surface of the substrate" and "an optical element provided

on the planar main surface of the substrate" and "one end of a slender light transmitter fixed in the groove and optically coupled with the optical element" as is required by claim 1. Beckwith requires that both tubing 5 and cable 4 inserted through openings 20 and 21 in body 2. (Beckwith at 2:59-60). Nothing in Beckwith teaches a construction in which the cable 4 and tubing 5 are not fixed through opening in the body 2. Further, nothing in Beckwith either teaches or suggests a construction in which the substrate has a groove on a surface of the substrate as is required by claim 1. Since Beckwith fails to teach or suggest this claim limitation, Beckwith cannot anticipate or render obvious the invention of claim 1.

Further, nothing in Beckwith teaches or suggests a construction with "one end of slender light transmitter fixed in the groove and optically coupled with the optical element." In Beckwith, flexible tubing 5 provides strain relief for fiber optic cable 4. (Beckwith at 2:58-60) Further, both tubing 5 and cable 4 are retained in openings 20 and 21 in body 2. (Beckwith at 2:59-60) Conversely, in the present invention, the slender light transmitter is fixed in a groove on the surface, no flexible tubing 5 is used and as such, only the slender light transmitter is fixed in the groove. Nothing in Beckwith either teaches or suggests a construction in which a slender light transmitter is fixed in a groove, in which flexible tubing 5 may be omitted or in which slender light transmitter is fixed in the opening without the assistance of tubing 5. Since Beckwith fails to teach or suggest this claim limitation, Beckwith cannot anticipate or render obvious the claimed invention. As such, claim 1 patentably distinguishes over Beckwith.

The Office states that Miura et al. explicitly teaches "the use of optical packaging substrates with v-shaped grooves and disposing at least a portion of the optical devices in a substrate groove (Fig. 11)." (Office Action, at p. 4, 2nd full para.) However, as noted supra, nothing in Miura et al. teaches or suggests the construction of present claim 1. Specifically, Miura requires a plurality of V-grooves 54B and a recessed portion 54C are formed on a mounting board 57 (the silicon substrate) by etching. Thus, in Miura et al., the planar main surface does not contain both the optical element and the groove as is required by the present

invention. Thus, since the combination of references fails to teach or suggest each limitation of present claim 1, the combination of references cannot render the claimed invention obvious. Withdrawal of the objection and allowance of amended claim 1 is respectfully requested.

Claims 2-4 depend from claim 1 either directly or through intervening claims. As such, claims 2-4 are patentable for at least the same reasons as claim 1. Withdrawal of the rejection and allowance of claims 2-4 is respectfully requested.

As with claim 1, claim 5 includes the limitations requiring "a substrate having a planar main surface and a groove in the main surface of the substrate," "a planer lightwave circuit provided on the main surface of the substrate," and an optical fiber partially provided in the groove." Claim 5 is therefore patentable for at least the same reasons as claim 1 (described above). Withdrawal of the rejection and allowance of claim 5 is respectfully requested.

Claim 6 depends from claim 5 and is patentable for at least the same reasons as claim 5. Withdrawal of the rejection and allowance of claim 5 is respectfully requested.

Claim 7 includes the limitations requiring "a substrate having a planar main surface and a groove in the main surface of the substrate," "an optical element provided on the main surface of the substrate," and "one end of a slender light transmitter fixed in the groove." Claim 7 is therefore patentable for at least the same reasons as claim 1 (described above). Withdrawal of the rejection and allowance of claim 7 is respectfully requested.

Claims 8-17 depend from claim 7 and are patentable for at least the same reasons as claim 7. Withdrawal of the rejection and allowance of claims 8-11 and 13-6 is respectfully requested.

Applicant believes the foregoing amendments place the application in condition for allowance and early, favorable action is respectfully solicited.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los

Angeles telephone number (213) 337-6810 to discuss the steps necessary for placing the application in condition for allowance.

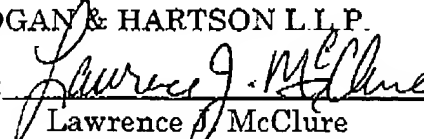
If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,

HOGAN & HARTSON L.L.P.

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Version with markings to show changes made:

1. (Twice Amended) An optical module comprising:
a substrate having a planar main surface and a groove in [a] the main
surface of the substrate;
an electric connection terminal provided on the substrate;
an optical element provided on the planar main surface of the substrate, the
optical element being connected with the electric connection terminal; and
one end of a slender light transmitter fixed in the groove and optically
coupled with the optical element.

2. (Amended) The optical module according to claim 1, wherein the
substrate includes a first base member and a second base member, the first base
member being provided with the electric connection terminal, and the second base
member having the planar main surface and being provided with the optical
element and the slender light transmitter.

5. (Twice Amended) An optical module comprising:
a substrate having a planar main surface and a groove in [a] the main
surface of the substrate;
an electric connection terminal provided on the substrate;
a planer lightwave circuit provided on the main surface of the substrate, the
planer lightwave circuit being connected with the electric connection terminal; and
an optical fiber partially provided in the groove and optically coupled with
the planer lightwave circuit.

7. (Twice Amended) A combination comprising:

a connector connectable with an electric circuit board; and

an optical module including:

a substrate having a planar main surface and a groove in [a] the main surface of the substrate;

an electric connection terminal provided on the substrate, the electric connection terminal electrically connectable with the connector;

an optical element provided on the main surface of the substrate, the optical element being connected with the electric connection terminal; and

one end of a slender light transmitter fixed in the groove and optically coupled with the optical element.